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The Regulatory Framework for Renewable Energy Sources

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Abstract

This work offers an analytical view about the problems related to electricity generation using fossil fuels and the role renewable energy can play, especially solar photovoltaic and wind energy applied to distributed generation, diversification. An analysis of the historical development of the regulatory framework posed in a group of countries. Also, an analysis of the main consequences associated with the deregulation of the Ecuadorian market linked to renewable sources is presented. Photovoltaic energy is mainly considered, as well as an insight on the importance of implementing an appropriate regulatory system, and support measures which regulate new ways of generation and supply of energy. The main concern is mostly related to the incorporation of independent producers as a new pattern in the system of power generation in the country. New concepts are considered for drawing supportive measures and specific regulations related to RES as well as the competence of a group of specific regulations which aim at regulating the payment of the electricity generated by independent producers. Chromatic scale maps are shown in the study of solar and wind, which can be used to make the feasibility studies prior to the introduction of technologies that allow us to use these sources.

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1. Introduction

Alatorre *et al.,* (2013), the use of energy has evolved over time, but it has become giddy in a range of fewer than three hundred years from the Industrial Revolution (1750-1850). Energía *et al.,* (2005), it is almost infinitesimal compared to the hundreds of thousands of years of human history.

The use of fossil fuels (oil, gas, coal, etc.) has been so rapid and indiscriminate which has altered the ecological balance. Now this situation threatens the very existence of the human species.

Since the beginning of electric power systems in the late nineteenth century to the present, these electric power systems have not been able to obtain a superior advantage up to 30% on an industrial scale of primary energy contained in hydrocarbons. The remaining 70% is derived in a sort of defiling economic loss which poisons the atmosphere increasing the generated kWh and which make unsustainable the current energy system.

It can be observed that during the first half of the twentieth century with fuel prices quite low, oil consumption rose exponentially. Energía *et al.,* (2005), and after World War II, oil became the main source of energy. In those years the various branches of scientific knowledge could not prove the negative environmental impacts derived from the management of fossil fuels to generate usable energy at the social level, especially oil and therefore was not a political priority which worries about such damage.

And today is a scientifically demonstrable fact that it is not possible to achieve the sustainable development of humankind on the basis of the current centralized energy system which is dependent on fossil fuels.

At present Ecuador has changed its production model, for this purpose, Ecuador has considered the structure of the sectors of production of goods and services. As well as organizing it according to the relative importance that each sector has in national development. For which a gradual increase is expected in energy demand, especially in the sectors related to the industry. Fonseca, (2014) to guarantee that new paradigm, Ecuador is committed to changing the energy matrix. This energy matrix since its emergence in the twentieth century was based on a strong thermal component based on burning oil.

The aim of this work is to show an evaluative analysis of the evolution of the introduction of renewable energy sources, especially photovoltaic technologies connected to the network. In European countries in order to have success in these applications, was necessary the creation of an independent power producer, was required to regulate new bidirectional relationships of generation and consumption, and for which a regulatory framework followed the new transformations in the energy scenario, as well as offering a conceptual foundation to facilitate the design of the regulatory framework and group support measures conducive to the introduction of technologies that take advantage of Renewable energy source (RES).

2. Research Methods

The work has been developed complying with methods that respond to the concepts of multidisciplinarity scientific research, which facilitated the execution of this work This allowed to meet accurate conclusions on the subject studied. Mena (2011), the cartographic information was obtained from the one published on the website of the regional scale of 1: 250,000 versions January 2013 layers of Basic Geographic Information from the Military Geographical Institute (IGM) of free access. (UTF-8).

For getting information associated with solar and wind energy potential, databases published on the website of the NASA Whitlock *et al.,* (2000) were used. the PVSYST Quintana & Díaz, (2013), the software was used for simulations that enable the realization of energy calculations and interpretation of meteorological data.

A group of theoretical methods of scientific research was combined, such as: The scientific method of analysis/synthesis in the study of available bibliographical material; The legal theoretical method for examining the energy regulatory framework internationally and in Ecuador; The legal comparative method, which allowed assessing the influence of regulations adopted in other countries and then compare them with the proposed; The logical, historical method in order to offer precise and logic considerations about development of Ecuador's energy matrix and its evolution in previous years; The method of induction and deduction which led from the existence of the contents to the object of study, obtaining own conclusions, thereby allowing deducing the essences, the causes and the reasons of proposals and final recommendations;

The exegetical method allows the philosophical and historical interpretation related to the evolution of the energy profile internationally and the country itself.

All of the above applies to the effects of revealing the essence of the scientific problem in processing information and the definition of the system of central and operational categories. In addition to reaching their conclusions which

may be useful to address an adequate conceptual framework that enables the layout of an energy regulatory framework with the seal of priorities, problems, and possibilities of the various regions and areas of Ecuador and especially in the province of Manabí.

3. Results and Analysis

General characterization of the world stage and social reaction

Technological development and intensive use of hydrocarbons and nuclear energy have led the man to the cosmos, modern means of transportation incredibly shorten distances and new technologies of computing and communications have reduced the cultural gulf between nations ; but at the same time they have created two parallel worlds: one where the man is able to solve all their problems and meet the most basic needs or whims; and the other a world lacking of the most urgent resources, which is uncertain between the limits of poverty, hunger, poor health, illiteracy, and marginalization in a polluted, and fragile environment which is worsening social situation of this marginalized population.

It has been shown that the responsibility of human beings to the process of loss of biodiversity and the depletion of natural resources is given at a rate ranging between one thousand and ten thousand times faster than the process that occurs in a natural way. On this basis, we calculated the loss during the XXI century of two-thirds of all species and the depletion of oil and other necessary development mineral resources. Viamonte (2007), this means that in terms of living species is equal to the disappearance produced in the Cretaceous period which took place five million years before the ecological balance was achieved, this means five times the age of man on earth.

In 1984 a group of German scientists detected signs of deterioration in forests even though the problem of acid rain was already widely known. Viamonte (2007), in the same year it was reported that the land lost annually eleven million hectares of forests and in 1985 two British scientists reported the discovery of ozone depletion over Antarctica.

Today we can say that the combustion of hydrocarbons is responsible for most of the air pollutants that cause various negative effects on the natural environment. There is a very important commitment to the activity associated with the generation of electricity from the combustion of the fossil.

The imperial policies of development have caused serious effects in the environmental component. Machicado (2009), production and overconsumption of energy has played a key role to become aware of the finite nature of the resources in the biosphere, and the need to maintain economic and social development without compromising the enjoyment of an adequate environment for present and future generations.

Viamonte (2007), the social pressure arising from the economic effects of the first oil crisis of 1973 and the scientific evidence demonstrating the serious impacts caused by human intervention to the environmental component which led a group of European countries put into execution different types of policies and regulatory initiatives aimed at promoting the use of RES since the 80s as a safe alternative to address the serious problem of ensuring sustainable energy development for ages to come.

3.1 The new energy regulatory determination and its impact

Through the years some of the policy initiatives to promote the use of RES were warmly welcomed by other countries in the world and have had a very important influence on the development of the renewable energy market. In some countries, the new energy policy has taken the form of government legislation, while in others these policies are set at the level of provinces, municipalities, even by ministries or other institutions.

Currently, the political objectives of RES exist in more than sixty countries. In 2007 at least 64 had a national target based on renewables, including the 27 countries of the European Union. Coviello (2003), in addition to these, 29 states in the United States (and the District of Columbia), and 9 Canadian provinces have standards based on RES despite US and Canada national policies.

In Table 1 are shown in summary the main policies and measures to support renewable energy sources applied in some European countries and Büsgen & Dürrschmidt (2009), China which are leaders in implementing frameworks of RES.

The instrument of fixed rates has been the most commonly used. This type of measure was adopted by Denmark, Germany, Greece, India, Italy, Spain and Switzerland in the 90s.

Fixed rates stimulated innovation and investment in many countries by offering security in investors to recover the invested capital and make a profit. Coviello (2003), this mechanism had its first effect and impact in wind energy, then in photovoltaic solar energy, also in the energy use of biomass, and the development of small hydro-electrical systems.

Fixing the rate goes through a political process which depends on the economic and productive conditions of each region. Moreover, the importance of their differentiated considerations, in line with the priorities, constraints, availability, finance, and other elements are accentuated to be considered in the different parts of the country or a given area. In general, rates are commonly set according to the cost of production in order to get a reasonable profit.

The value of the rates may differ in each of the technologies so to get these values are taking into account the size, application, location, and quality of the resource.

The differentiation of the amount of the fee has been directed to encourage more applications. An example of this can be often seen in solar photovoltaic energy as rates are different if placed on the floor as part of large installations, or if the panels are integrated into the building or ceilings. The last ones mentioned are more efficient since they reduce losses and consumption of other primary sources of energy (oil and water). This avoids economic spending on new investments based on technological infrastructure, greater regionalization of electricity generation, achieve a better utilization of space, and achieve a lower environmental impact.

Table 1
Main regulations implemented in some European countries and China

No	Regulations implemented	Countries				
		Germany	Spain	Denmark	Australia	China
1	System of flat fees	X	X	X	X	X
2	Premium system		X	X		
3	Renewable portfolio standards			X	X	X
4	Tender system	X	X	X		X
5	Subsidies of RES	X	X	X	X	X
6	Concessions	X	X	X	X	X
7	Tax rebate on exports	X	X	X	X	X
8	Production and tax credit extensions	X	X	X	X	X
9	Prizes	X	X	X	X	X
10	Special purpose funds of RES	X	X	X	X	X
11	Net Balance	X	X			X
12	Net Metering	X	X			X

Source: Prepared by the author based on Büsgen & Dürrschmidt (2009).

Moreover, the rates may also change depending on the size of the project. This differentiation has been implemented to support smaller projects which tend to be more manageable in terms of contingencies and provide better access to investment opportunities for the private sector.

Small projects can not be profitable if fees that are used for large projects are implemented. In Germany, biogas projects are diminished when their rates are greater than 150 kW; Small projects are also suitable to promote the development of technologies in remote regions difficult to access or where it is a priority to develop certain renewable source.

The difference in the rate depends on the quality of the resource which contributes to the development of these technologies not only in one region of the country instead they will spread evenly in different regions.

In Ecuador, there is a strong concentration of hydropower in the highlands, while oil generation is concentrated in the east. The coast region is dominated by thermal generation based on the burning of oil which influences the increase in losses and environmental pollution with the rising cost of kWh served.

The dispersion of projects for generating electricity has positive effects to minimize fluctuations in the generation due to the variability of the resource. This will surely help to eliminate potential imbalances in the social development

of the different regions and localities. The premium system represents practically a change in fixed rate system. The most common in Europe is the use of the fixed rate. The premium system has been used mainly in Spain and Denmark.

The premium system is a mechanism by which an additional payment is added on the maximum market price of electricity. This means that a premium is added to a base price fixed previously. In the case of fixed rate, the producer receives a separate payment of the price of electricity on the market. In the case of a fixed premium system, the price of electricity on the market influences the additional Coviello (2003), payment. The awards are payments for power generation or credits for the production, or acquisition of technologies of RES. This usually consists of fixing the prices kWh generated which is a basic condition for the application of the system of rewards Coviello (2003), and at the same time is like a spring stimulating investment since it ensures an economic compensation for the amount invested.

At least 52 countries around the world have received some form of direct capital investment, subsidies, grants, and import tax refunds, also an incentive and financial support. A group of countries has established special funds of RES which are directly used to finance investments, and provide loans with low-interest rates or facilitate the development of markets for example, through research, education, and qualifications or standards performance. Coviello (2003), the quota system comes in two types or variants of RES: the renewable portfolio standards and the system based on tenders.

Renewable Portfolio Standards or quota system are considered at states in the United States, Canada and India, and seven countries like Australia, China, Italy, Japan, Poland, Sweden, and the United Kingdom. The quota system is an obligation (not voluntary command) that sets the government on companies or consumers to provide or use a minimum level of participation (by mandate) RES either of installed capacity, generation, or energy sale. These obligations may be accompanied by penalties for non-compliance with the goal of participation. In the mechanism of renewable obligations or quota policy, the government regulates the amount of renewable electricity and let the market determine the price. This means that this system does not set the price or the fee of energy. A goal is set to establish a minimum amount of capacity or generation to be covered with RES which should increase from time to time.

Among the new support mechanisms that have emerged more recently and have found successful application in some Latin American countries like Mexico and Brazil are the Balance Sheet and Net Metering. Net Balance considers in a predetermined time (the most commonly used is one year) the excess of energy which is delivered to the network so it could be terminated in case of overconsumption. This mechanism could be fair and beneficial in countries with low subsidies to electricity and where payment rates for electricity are a real burden for consumers. In these cases, the networked systems can avoid a significant amount of electricity bills and these savings can be taken with a benchmark indicator to calculate the economic payback. In the case of countries like Ecuador which has a flat rate for collecting payments due to electricity served in the entire national territory. The government subsidizes much of the actual cost of electricity; the mechanism of the net balance can not result appealing for private investors, but for state entities that can apply this mechanism. Public entities depending on boosting investments that achieve the use of renewable sources available, easing the state's economic weight motivated by the electricity subsidy. Net Measurement is based on measuring the energy delivered to the network according to what is consumed. It allows selling electricity to the distribution company with a corresponding equivalent of the cost of service availability.

The mechanism of Net Metering can be fair and beneficial to independent producers, cooperatives, associations and organizations that invest in renewable sources to provide energy to the power grid. The payback for the energy supplied to the network allows them the return of the capital invested and obtain a reasonable margin of economic gains from energy input to the network. Both mechanisms seek to alleviate the enormous burden that falls on the shoulders of the Ecuadorian state which is subsidizing part of the electrical service. These mechanisms report other benefits related to reducing losses of transportation and distribution of electricity, saving the consumption of other sources more expensive than primary energy as (oil and water), minimizing expenditure on new technology investments, encouraging regionalization of electricity generation, leading to increasing reliability and quality of electricity service.

Other policies implemented are the goals and objectives of the RES. Currently, there are at least 64 countries with national targets, including 22 in development, among China which gives considerable attention to its long-term goals about RES. These technological goals are reflected on 300 GW of hydropower, 30 GW of biomass and 1.8 GW of solar photovoltaic. The satisfaction of the objectives reached by China is expected to triple the installed capacity in the country FRE 2020.

The case of the European Commission which in 2007 adopted new mandatory targets for 2020 can be highlighted. In this new scenario goals are broader, reach 21% of electricity, and 12% of the primary energy of RES. And some countries have already legislated individual measures. In the particular case of Denmark which is ranking as one of the leading European pioneers for its legal regulation of a group of social relations derived from the use of renewable

sources. Since the mid-70s, the Danish state displayed a political determination in some provinces and Peruzzo (2007), municipalities to support the initiative of the Community Power.

The project of the Community Power consists in supporting Danish participation in projects of renewable energy sources. All this in order to control environmental concerns, generate local benefits and increase social acceptance of new changes. It is the rule of thumb that more citizens will have generators in their neighborhoods and this will be of crucial importance. Looking at it from the perspective of a large-scale change to renewable where citizens are evidencing a positive attitude towards those units. A very important precondition is to involve local communities and citizens as owners, managers, partners, and beneficiaries of the projects in their backyards, Peruzzo (2007), to achieve broad social support for renewable energy sources.

3.2 Special features in the case of Spain and Germany

The current Spanish energy model is based mainly on the great weight of hydrocarbons forced by the brutal increase in electricity demand in recent years. This average is over 5% and there is a significant increase in demand for gas which tries to reduce impacts to the environment but it is not enough to eliminate them. As a summary, these reasons have been more than enough to deal decisively with the replacement of traditional energy model for one based on savings, efficiency, and renewable.

As a result of the growth of renewable sources in Spain, the electrical power average generated in the country has evolved in recent years from 56% of the energy generated in power plants. It has evolved from fossil fuels in 2000 to an increase in renewable energy since 2009 covering 26% of the electrical demand. Between 2005 and 2011 the wind caught 9,028 million in premiums and produced savings for the country worth 12,101 million euros. However, at the present time when the major European economies are betting on the competitiveness of photovoltaic energy, the Spanish government has inexplicably turned its back to the development of this technology. This has been a setback in terms of sustainable energy development which Pacheco (2010), is affecting the competitiveness of the Spanish model in the international energy market. For these reasons, it can be inferred that the current Spanish example in terms of expansion of photovoltaic energy is not suitable for any country in the world today, as they could reproduce the same mistakes with similar consequences.

In 2000 the German government welcomed the Renewable Energies Act (Erneuerbare Energie Gesetz, EEG). This law has significantly helped the photovoltaic industry. It requires that operators of the national electricity grid pay a higher price to providers of solar energy than traditional energy providers. Germany has positioned itself as an excellent location for investment in solar energy, due to strong government support, the availability of highly skilled workers, abundant supply centers, and universities in scientific research. For example, Germany plans to increase the share of 25-30% by 2020, and then continue to increase this participation in order to reach 45% by 2030.

As a distinctive feature of Germany can be distinguished the expansion in the field of contributors on the use of photovoltaic energy in all possible formats. It is mainly applied in installations of small and medium photovoltaic systems installed on the roofs of the buildings. They are very close to load centers thereby avoiding losses due to distribution and transportation. In 2012 this policy allowed that more than 20% of the energy consumed in the country Durán (2014), was generated from the use of the solar resource. By the end of 2012, Germany implanted solar and wind power. And 50% of solar energy is owned by individuals and farms while 54% of wind power is in the hands of the same groups.

The effect of boosting the initiative of independent owners of the private sector in photovoltaic installations can be clearly seen when in 2012 Germany reached 17 GWp installed of this technology in contrast with 3.6 GWp in the US in the same year. It is important to mention that the US focuses on large connected grids systems to the distribution network devastating the idea that the way of applying the photovoltaic is the most ambitious. By 2015 the Germans electricity grid had turned out to be almost 30% solar and wind power compared to almost 0% around 15 years ago which Friedman (2005), has been a great contribution to the stability of the planet and its climate.

The enormous advantage in solar energy possessed by Germany compared to other countries is that ownership of energy mostly is in the hands of individuals or associations. It means a democratic change in control of resources and a break in the way electricity and energy have occurred over the last century. The resources available are displayed in: decentralization of power generation, increase in relocation and regionalization of the energy economic activity. It is a fact that the more connected the world becomes, the smaller it gets.

3.3 The Ecuadorian scenario

Looking at the Ecuadorian scenario, the change of the productive matrix and the profound changes being made in the energy matrix can be highlighted.

This will also require important conceptual changes in the system regulations pointing to the direction which currently induces to the scientific and technical international development. All these going toward sustainable energy based on the use of renewable sources of environmental conditions. And towards flexibility and decentralization legislation which means neither disorder nor anarchism. In addition multidisciplinary integration of processes for the socialization of energy management under the paradigm of achieving shared values and responsibilities. These with the purpose of accomplish efficiency and savings and to integrate employment and utilization of resources.

The integration of renewable sources in the national energy scene and the practical application of technical concepts associated with distributed generation constitute a potential generator of major new social relations of production and reproduction of energy resources and services. The most benefits could be gotten particularly by using solar energy through the introduction of photovoltaic systems and wind potential by wind technologies connected to the network. These applications are propitiating the emergence of new jobs and the income into the energy scene of a new figure, the "independent producer of energy". What was mentioned before is bringing the context of electricity generation to a new type of two-way relationship in terms of production and consumption as forms of remuneration for the energy supplied to the network?

In the current Constitution of 2008, Title III establishes a new structure for the electricity sector in two large segments called institutional structure which comprises the Ministry of Electricity and Renewable Energy and the Agency for Regulation and Control of Electricity, the National Operator of Electricity and specialized institutes; leaving the business structure for Public Companies, Mixed-Economy companies, private companies, consortiums or associations and companies of Popular Economy and Solidarity. This states that the responsibility for the electricity sector is the Ministry of Electricity which Peña *et al.,* (2005), has the concessive powers that previously were managed by CONELEC.

If analyzed with a general profile of political spirit in the constitution, it can be seen clearly that the Ecuadorian legislature was able to foresee the contextualization of a revolutionary figure in the current energy scenario, "the independent producer of energy "and even in Article 10 of the Organic Law of the public service of Electric energy Público (2010), refers in more than one figure which characterizes in correspondence to their possible origin and constitution. It is explicitly referred to in the Act to Mixed Economy Companies; Private businesses; Consortiums or associations, and Business of Popular Economy and Solidarity. And it follows that the reference is especially linked with the management and use of renewable energy sources. However, the legislature has fallen far short when the independent private producer is not legally displayed as a person who has a facility from home and can sell electricity to the trading company after covering their needs.

In the previous Constitution of Ecuador in 1998, it had opened the legal possibility that the service could be provided directly by the State or by granting to mixed or private companies; but this legal measure did not get outcomes during the decade of its validity. It is possible that the system operators which should have implemented and enforce the will of the legislature. At that time, they may have considered pejoratively as a last resort privatization measure and therefore legislature did not create conditions to promote their realization. This should be clear that compliance with regulations should not be at the expense of the willpower of the operators of the system even if they seem revolutionary, progressive and positive. Law invokes the spirit and will of society and must be fulfilled independently of the role played by humans. Those are the rights of any society, respect for the law and citizen legality.

The Ecuadorian state policy in 2009 recognized the boost role of wind energy would play. At the same time, it was proposed that solar, wind and geothermal energy proved limited in supply, infrastructure, and ratio of application. However, it was foreseen at the time that in the future undoubtedly, it would come to occupy a significant place in the national energy matrix. Gámez *et al.,* (2017), it is related to ensure technical system reliability in any conditions of the situation, and because specialists had identified the risk which represented the main energy that depended solely on the hydraulic source. But the operational reality is that it has more than five years and what is happening with the non-hydro renewable energy, especially photovoltaic, is proving that very little has served the international experience, including the statements that were made in the year 2009, when Gámez *et al.,* (2017), it was announced that future undoubtedly solar, wind and geothermal would come to occupy a significant place in the national energy matrix.

The reality is that the current deregulation of the market for non-hydro renewable sources and the inoperability of the procedures for applying for investment, especially photovoltaic. This is giving the opportunity for exclusivist photovoltaic market and mostly not to be all under the influence of foreign capital investments with very little chance

of Ecuadorian private sector participation. Most investments that have been carried out so far correspond to photovoltaic plants that have been connected to the distribution network, fostering a process of concentrated capturing. Then raise the voltage by a transformer and incorporate it into the distribution line which implies then decrease voltage by another process. After this, it is going to be supplied in a distributing way for consumption. All these processes involve losses that make the system inefficient with an effect that may delay the economic recovery period of investment.

It is important to mention that solar energy is the most distributed source on the planet. In the case of Ecuador, it reaches virtually everywhere with the same intensity which constitutes a rich heritage of Ecuadorians. Under these conditions, it may not be technically the most appropriate to concentrate an energy resource which by its nature is already distributed and that there are technological possibilities of using it in a distributed way. This would result in more efficient, less complex, less expensive, and with a value added to promote the reduction of losses. It is important to understand that electricity is a public function with an extraordinary influence in all spheres of society. Proper regulation is very important for the stability of economic activities and services. In addition, it is very important the responsibility and order of sectors in society with its realization commitment. The current consequences of the deregulation of the energy market of renewable sources in Ecuador are leading the bid prices on the domestic market of photovoltaic technologies in some cases almost triple the bid prices on the international energy market. This situation is less well understood when renewable technologies are supposed to be exempted from tariff rates to enter the country.

In the Ecuadorian energy market, polycrystalline silicon photovoltaic modules are quoted at $ 1.50 Wp. Guerrero (2013), these prices skyrocket the cost of photovoltaic kWh which are very uncompetitive levels, including the energy generated based on fossil fuels. The Chinese market offers technology based on monocrystalline silicon, which is the most efficient. This is quoted at 0.61 dollar Wp Sarmiento (2012), located in the port of Manta. Ecuadorian bidders argue that prices are justified by the quality of the modules; however, it is known that the overwhelming majority of photovoltaic technologies available today in the global energy market are invoiced in China which dominates worldwide the market for photovoltaic technology being standardized in all market niches. The problem associated with deregulation of prices in the market is leading to a continuing, an old, and decontextualized deprivation opinion of photovoltaic energy related to the high cost of the initial investment. On the other hand, today prices in the photovoltaic market dominated by China have very competitive costs with any of the other energy sources.

The failure to regulate the price of kWh generated to be paid to independent producers fosters uncertainty and insecurity for potential private investors. It should be considered that studies of technical and economic feasibility are a sine qua non that must be performed by trained personnel in management methodologies and proprietary tools associated with renewable technologies. Policy and financial regulation intended to support and encourage for making investments in renewable sources of independent producers only addresses the opportunities in hydropower but not in the solar, wind and geothermal. In Ecuador, there are no policies or regulations that encourage the commercial development of wind technology medium and small formats which limits its application and use of this renewable source.

3.4 The search for other sustainable energy alternatives and their regulation

The aspirations of economic and social development of the Ecuadorian state for the coming years requires a sustainable energy matrix structure which does not depend on oil even though it is considered as an element of technical safety. This paradigm of energy sustainability can only be achieved through the use of renewable energy sources with a comprehensive vision, prioritizing hydropower and boosting photovoltaic energy considering the extraordinary potential of this energy source that affects coastal areas where there is not a significant potential of hydro or wind energy.

Currently, there are no legal or technical standards which control development policies of renewable sources in an integrated manner or encourage the adoption of a differentiated regulatory framework in different regions, provinces, and districts, dealing with the problems, priorities and economic possibilities of each zone and territory.

For Ecuador would be very difficult to make progress in building a sustainable energy system at the expense of renewable sources without building a general regulatory framework in the country. This system should be able to release and perform the regulative determination particularly in the regions, areas, provinces, and municipalities after considering the priorities, technical problems and financial capacity of each instance. All these to procure the adoption of policies and support measures, and the incorporation of potential independent power producers who would be able to incorporate and put into play new contributions to sustainable energy resource development of Ecuadorian society. This indeed will relieve the weight of the energy problem which now lies almost absolutely in the state.

It has been demonstrated in the regulatory practice of countries more advanced in the use of renewable energy sources for electricity generation that these objectives are achieved basically by deploying a well-defined and positioned political determination on the concepts of sustainability. This is done in order to establish a whole system of measures, support mechanisms and regulatory documents that offer technical and economic guarantees and stable incentives for periods of time stipulated reasonably.

The result of the studies of the solar potential conducted in Ecuador shows that the only energy source that is distributed and available in the three regions (Coastal, Highland, and Amazon) Whitlock *et al.,* (2000), are solar energy although higher annual average levels focus in the coastal areas. Figure 1 shows the map of the annual solar average potential in Ecuador where you can verify what was stated above

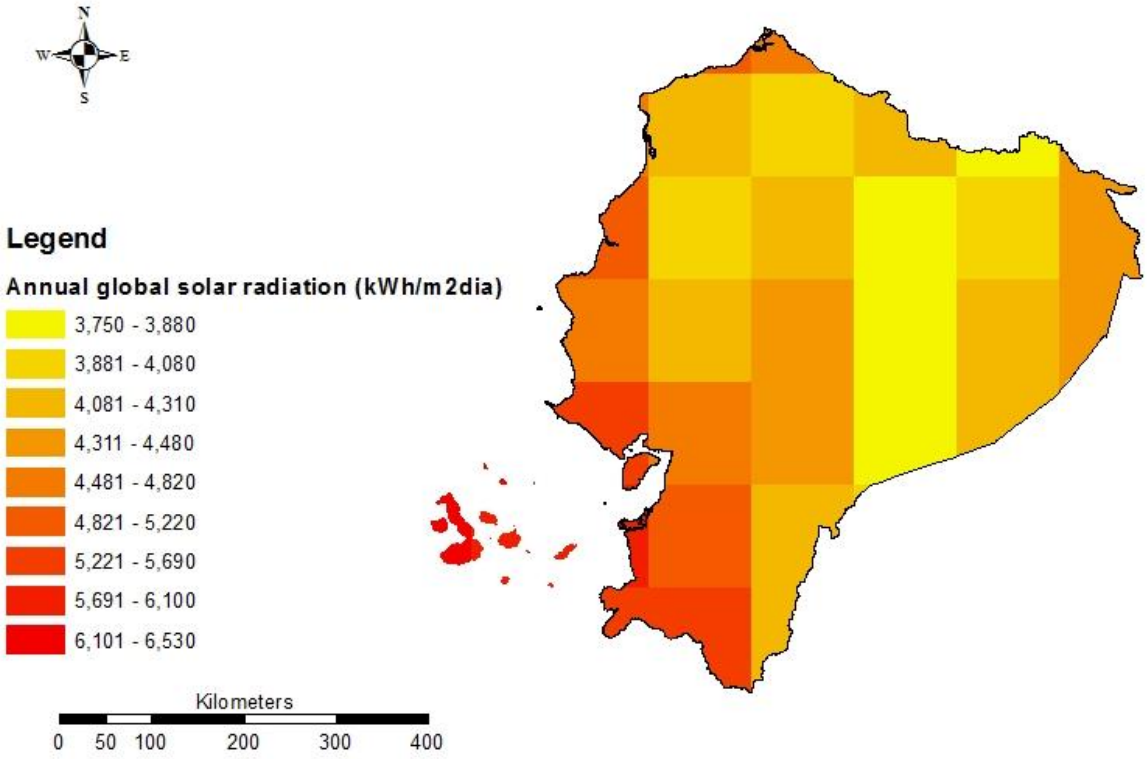

Figure 1. Map of the annual solar radiation in Ecuador. Source: Whitlock *et al.,* (2000).

Average daily solar radiation incidence in Ecuador is about 4.3 kWh / m2, being equivalent from the energy point of view to 121 grams of oil per square meter daily in the country. In one day Ecuador receives a solar radiation equivalent to 1,102 TWh which is more than 50 times the gross energy generated in a year by the country's National Interconnected System. These data give a clear idea of the extraordinary availability offered by solar radiation for Ecuador.

The availability of wind potential is manifested in a timely manner and does not always coincide with the sites of the energetic load. With the possibility of its wide use by small and medium installations (10 to 20 meters high) connected to the network in the mode of distributed generation in coastal areas where there is a high demand for electricity due to tourism. Figure 2 shows the map of wind potential of Ecuador, measured at 10 meters high. What has been analyzed here allows defining whether to visualize and implement a set of mechanisms, support measures, and specific regulations. All these in order to encourage the use of solar photovoltaic and wind energy in the mode of distributed generation in those provinces and areas where there is not good hydraulic potential, but there are a good sun and wind potential which should be considered and may be expressed as follows:

First, it requires focusing and setting policy goals involving solar photovoltaic and wind energy especially for electrical consumption in the short term. By 2020 in the provinces where the predominant consumption is thermal energy source based on oil consumption, these policies could be set as a long-term at this zone level and later in the country respectively.

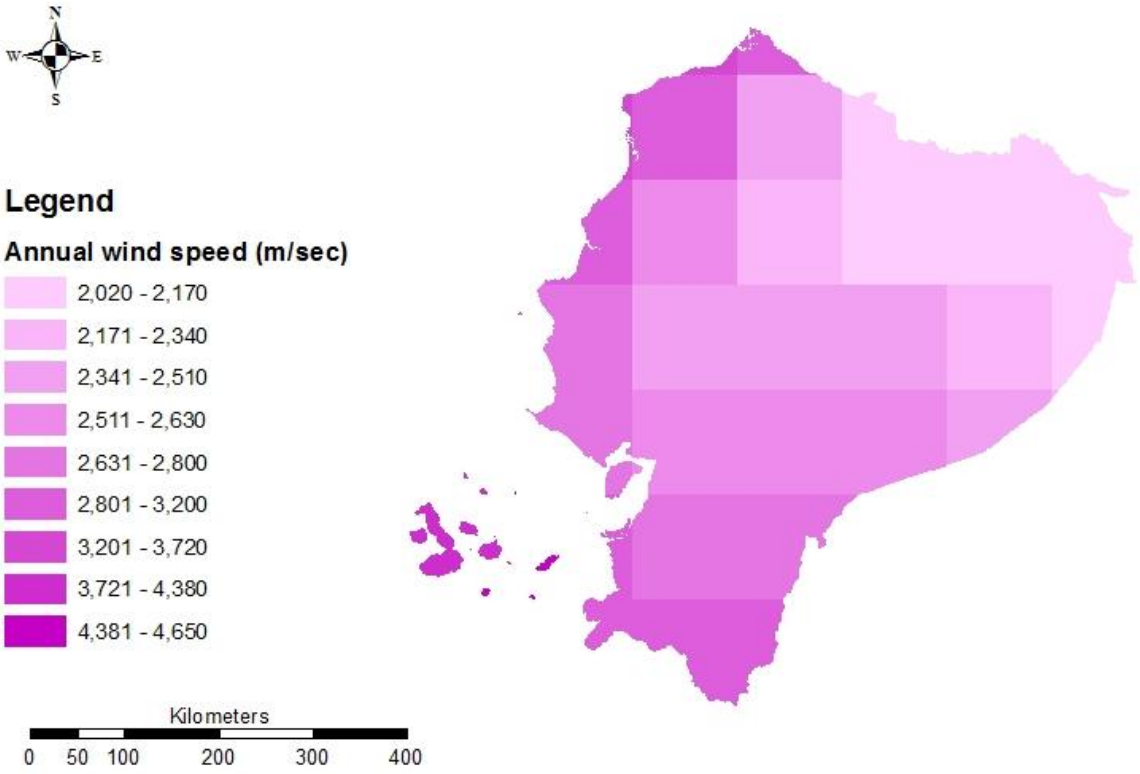

Figure 2. Wind potential Map 10 m height. Source: Whitlock *et al.,* (2000).

The political goals of participation of different energy sources could be directed to the following objectives:

a. In the total electricity consumption should be set a share target generation based on hydropower, solar photovoltaic, wind, and oil. In this case, it can be fixed in figures or percentages and the limits expected for each.
b. For the provinces where the predominant consumption of electricity of thermal origin based on oil consumption should prioritize investments in sources of photovoltaic generation and timely wind power mode distributed generation. By doing this, losses in transmission and distribution will reduce. In this case, it must be provided in percentages of the amount that pretends to be reduced.
c. Releasing the potential of integrated development of all energy sources, prioritizing the greatest potential.
d. Support and encourage investment by independent power producers (state and private sector), focused on: reducing the burden of state subsidy to electricity, reduce losses, diversify and regionalize generation sources, reduce the consumption of primary sources more expensive (oil, gas and water), reduce investment in transmission lines, distribution and associated technology components for supplying electricity such as transformers and other components, technically improve service quality, and achieve greater social commitment in power generation and electrical services.

The support mechanisms need to consider

Promote and encourage investment in renewable energy by independent producers (state and private) with its own resources and under the following conditions:

a. Facilitate management and access to bank credit by independent power producers, without interest and attendance at a duty-free Ecuadorian energy market.
b. Ensure facilities for connection to the network and simple system installation or bidirectional footage of energy, as applicable.
c. Set as the only requirement for projects of renewable energy, the presentation of the conceptual ideas and project, approved by qualified consultants and specialists in the subject.

Establish special rates for payment of energy to renewable sources independent suppliers, considering the following elements:

a. In all cases, the point where the footage or footage dual energy will be made must be specified. Experience indicates that the right place is the point of connection to the network.
b. Rates should be set for a reasonable time; usually, time is taken into consideration because of the useful lifetime of the technology. This result was very important for the effect of trust and security that can cause investors element.
c. The rates must be set differently for each source of energy (photovoltaic solar, wind, hydro, biomass and geothermal) and within each consider the recovery time of the investment and the remainder to meet the deadline of life technology.

Promote and prioritize the financing of projects aimed to study the potential of renewable sources of energy: solar; wind, biomass; geothermal, and tidal power. Promote and prioritize the financial support of projects for technological assistance to take advantage of the primary energy in renewable sources for heating fluids, pumping water, drying products, and other energy demands that can save electricity, being more efficient, and benefit the environmental component. Review, refine and implement regulations related to efficiency in electricity consumption.

4. Conclusion

The analysis shown in this research demonstrates that the policies, goals, support mechanisms, and the regulatory framework have been a potential development engine which has facilitated the diversification of power generation base through the development of renewable sources of energy in the pioneering countries that have decided to change the energy matrix.

Analysis of Ecuador's multi-diversity allows defining the elements linked to energy policy, targets, support mechanisms, and the regulatory framework. These can be studied and implemented in a decentralized manner according to the characteristics, availability of resources, and priorities of different regions, areas and provinces regardless of whether the nation centralized policies and goals related to energy development are set.

It was verified that the technical and social conditions conducive to the study and implementation of a regulatory framework and decentralized and differentiated energy policy which will stimulate the use of cheaper source of energy, more efficient, less impactful in Ecuador environment, and offers a measurable contribution to the balanced development of different areas and regions of the nation.

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Statement of authorship
The authors have a responsibility for the conception and design of the study. The authors have approved the final article.

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References

Alatorre, C., Alves, L., & Vergara, W. (2013). *Rethinking our energy future: A white paper on renewable energy for the 3GFLAC regional forum*. Inter-American Development Bank.

Alvear Sarmiento, A. M. (2012). *Plan de negocios para la producción y comercialización de energía eléctrica en base de paneles solares en el Distrito Metropolitano de Quito* (Doctoral dissertation, Universidad Internacional SEK).

Büsgen, U., & Dürrschmidt, W. (2009). The expansion of electricity generation from renewable energies in Germany: A review based on the Renewable Energy Sources Act Progress Report 2007 and the new German feed-in legislation. *Energy Policy*, *37*(7), 2536-2545.

Chávez Guerrero, M. A. (2013). *Proyecto de Factibilidad para uso de Paneles Solares en Generación Fotovoltaica de Electricidad en el Complejo Habitacional "San Antonio" de Riobamba* (Bachelor's thesis).

Coviello, M. (2003). *Entorno internacional y oportunidades para el desarrollo de las fuentes renovables de energía en los países de América Latina y el Caribe*. CEPAL.

del Servicio Público, L. O. (2010). Asamblea Nacional. *Editorial Nacional, miércoles*, *6*.

Domínguez Durán, D. (2014). *Autoconsumo en los sistemas fotovoltaicos* (Bachelor's thesis).

Energía, S., & Ambiente, M. Tabloide. 2005. *La Habana*.

Friedman, T. L. (2005). *The world is flat: A brief history of the twenty-first century*. Macmillan.

Gámez, M. R., Pérez, A. V., Wilber, M., & Guardarrama, J. R. (2017). El Potencial Solar y la Generación Distribuida en la Provincia de Manabí en el Ecuador. *Revista de Investigaciones en Energía, Medio Ambiente y Tecnología: RIEMAT ISSN: 2588-0721*, *2*(2), 41-45.

Machicado, J. (2009). Del desarrollo sustentable al desarrollo sostenible. *Apuntes Jurídico. Recuperado de http://jorgemachicado. blogspot. com/2009/08/dss. html*.

María, R. G. (2015). Sistema de Información Geográfica para el Desarrollo Sostenible"(SIGDES). *Facultad de Ciencias Matemáticas, Físicas y Químicas de la Universidad Técnica de Manabí*.

Osorio Fonseca, F. (2014). *Análisis situacional del mercado de valores y propuesta de cambios para convertirlo en una herramienta que apoye el cambio de la matriz productiva en el Ecuador* (Master's thesis, Quito: Universidad Israel, 2014).

Peña, B. E., Múgica, J. R. M., & Zaldua, E. M. (2005). Las políticas de desarrollo rural en la CAE: un balance. *Ekonomiaz: Revista vasca de economía*, (60), 90-109.

Peruzzo, C. M. K. (2007). Direito à comunicação comunitária, participação popular e cidadania. *Lumina*, *1*(1).

Quintana, E., & Díaz, R. (2013). Simulación de un sistema de acondicionamiento de aire por absorción con asistencia solar en panamá utilizando trnsys. *I+ D Tecnológico*, *9*(2), 48-58.

Rosas Mena, L. A. (2011). *Propuesta de delimitación y codificación de unidades hidrográficas de la cuenca del Río Esmeraldas a escala 1: 50 000, por método de pfafstetter mediante el uso de sistemas de información geográfica*(Bachelor's thesis, SANGOLQUI/ESPE/2011).

Sánchez Pacheco, C. (2010). *Sistemas de energía solar fotovoltaica aplicados a viviendas residenciales en entorno urbano* (Doctoral dissertation).

Viamonte, E. *Colectivo de autores.(2007). Derecho Ambiental Cubano. Editorial Félix Varela, Segunda edición actualizada y aumentada, 2007* (p. 5). ISBN 978-959-07-0434-5.

Whitlock, C. H., Brown, D. E., Chandler, W. S., DiPasquale, R. C., Meloche, N., Leng, G. J., ... & Kratz, D. P. (2000). Release 3 NASA surface meteorology and solar energy data set for renewable energy industry use. *Proceedings of Rise and Shine*.

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